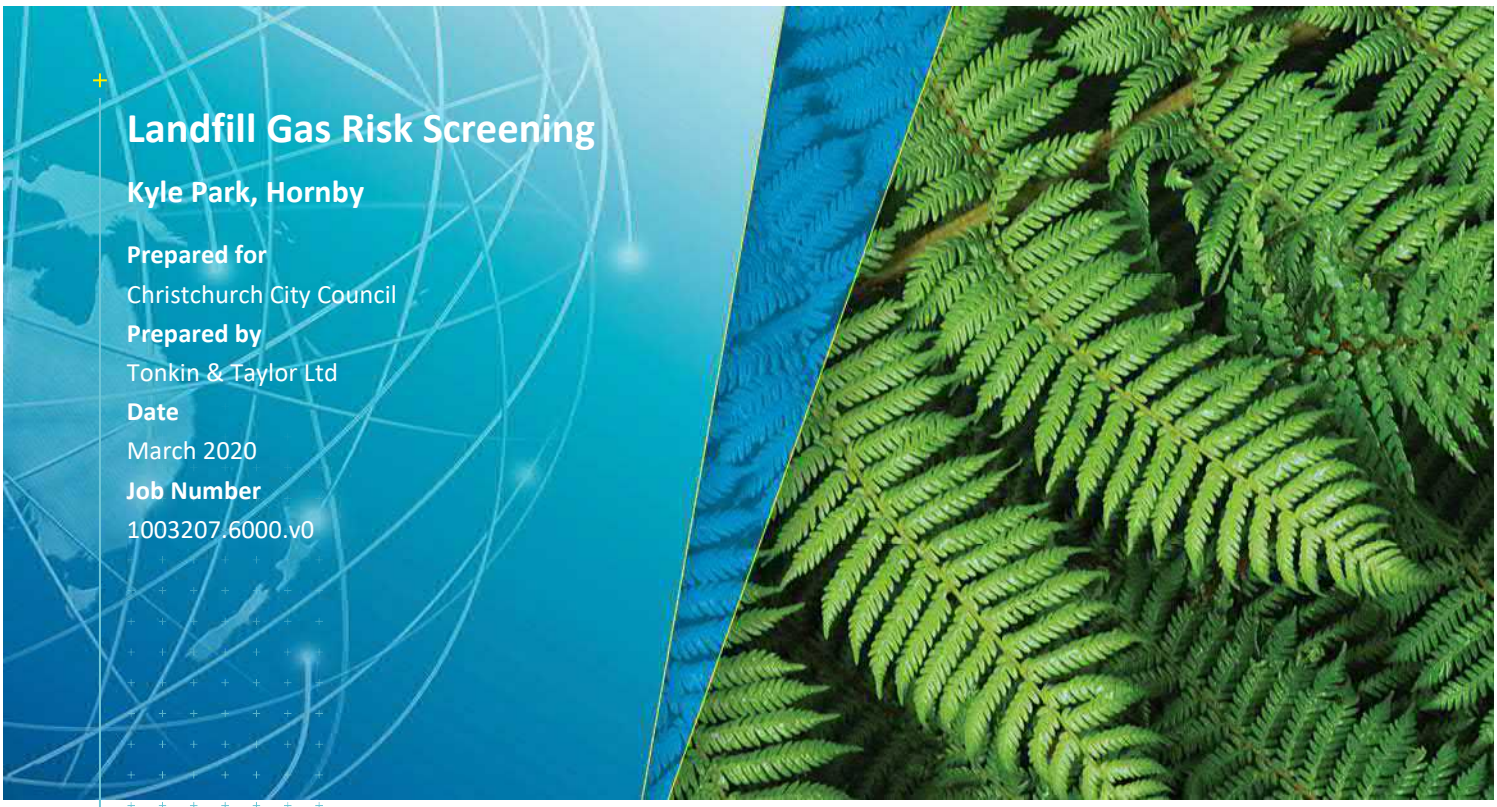
REPORT

Tonkin+Taylor



Landfill Gas Risk Screening

Kyle Park, Hornby

Prepared for
Christchurch City Council
Prepared by
Tonkin & Taylor Ltd
Date
March 2020
Job Number
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Document Control

Title: Landfill Gas Risk Screening					
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This report has been prepared for the exclusive use of our client Christchurch City Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Recommendations and opinions in this report are based on data from discrete sampling points and times. The nature and continuity of ground conditions and landfill gas conditions are inferred and it must be appreciated that actual conditions could vary from the assumed model.

Tonkin & Taylor Ltd

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Table of contents

1 Introduction

Tonkin & Taylor Ltd (T+T) has been engaged by Christchurch City Council (CCC) to undertake a landfill gas (LFG) risk assessment at the location of the proposed Hornby Library, Customer Services and South West Leisure Facility (the centre) which is to be constructed within Kyle Park, in Hornby, Christchurch (197 Waterloo Road). This assessment has been prepared to support the next stage in the centre's development, conceptual design.

This work has been completed in accordance with CCC Statement of Work agreement with T+T dated 22 March 2019.

1.1 Project background and objectives

CCC proposes to locate the centre in the north-eastern corner of Kyle Park (hereafter referred to as 'the Site' and shown in Figure 1.1). Concept design for the centre has not been undertaken, but at this stage it is anticipated that the centre would include:

- A two-storey service and library building, including community meeting rooms and offices;
- A leisure facility including swimming pools (fun and lane pools), sports hall with courts (multifunctional); and
- Car parking, landscaping and footpaths connecting the centre to the remainder of Kyle Park and to transport links and facilities at the Hornby Hub, located south of Kyle Park.

In addition, due to the present ground levels on the Site relative to surrounding land (see Section 2.1), the centre will be largely built on top of current ground level(s), with limited excavation into existing ground.

Figure 1.1: Kyle Park (red line) including the Site (blue line) (source - Canterbury maps).

Kyle Park was formerly a gravel pit and was backfilled with a mixture of uncontrolled fill materials (e.g. domestic, industrial and commercial wastes). Investigations completed by T+T at the Site in

2019 confirmed the presence of organic wastes and the potential for landfill gas to be generated as a result of the decomposition of that organic material.

CCC therefore engaged T+T to complete a landfill gas assessment in order to understand the potential implications that LFG may have for the design of the centre.

1.2 Scope of work

The LFG assessment comprised:

- The installation of four LFG monitoring wells (MW201-MW204) on the north, south east and west boundaries of the Site;
- Collection of LFG data from the four monitoring during 9 monitoring events between April and November 2019;
- Review of the monitoring data and completion of a risk screening for the proposed development in accordance with CIRIA C665[1]; and
- Outline the principles of LFG building mitigation/protection measures for the centre, based on the outcome of the LFG risk assessment.

[1] Construction Industry Research and Information Association (CIRIA) C665, Assessing risks posed by hazardous ground gases to buildings, 2007.

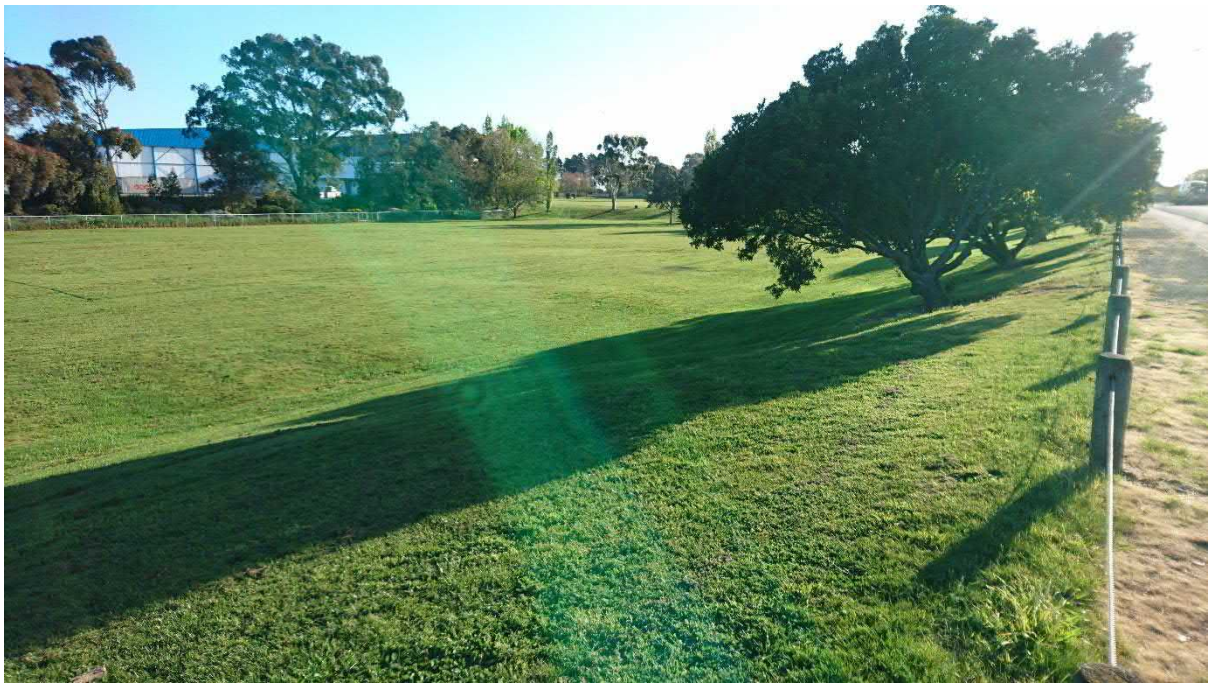
2 Site Characteristics

2.1 Site identification and description

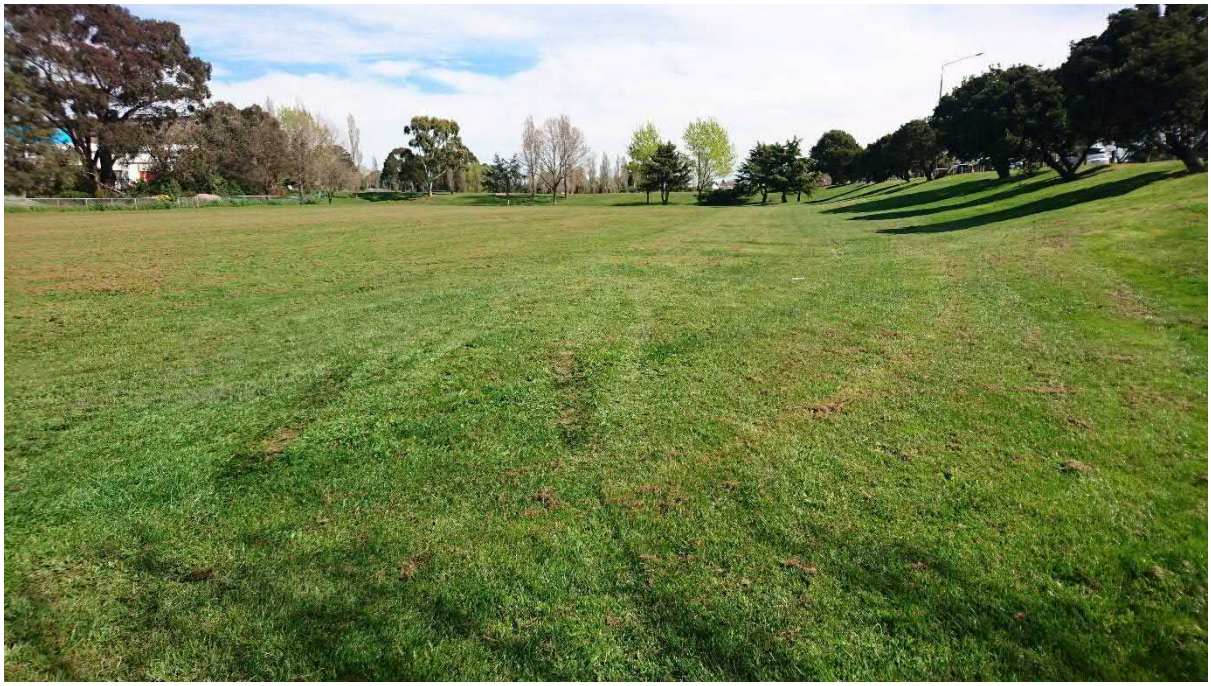
Kyle Park is located on the southern side of Waterloo Road, in the suburb of Hornby. The Site is located in the north eastern corner of Kyle Park and is surrounded by:

- Waterloo Road to the north with Hornby High School immediately north of Waterloo Road;
- Smarts Road to the east and commercial properties beyond;
- Commercial properties to the south; and
- The majority of Kyle Park to the west (refer Figure 1.1).

Photographs 1 and 2 below show the general setting of the Site and the current ground levels there, which are approximately 2 to 2.5 m lower than the surrounding area (i.e. Waterloo Road, Stuart Street).



Photograph 1: View of the Site from the north east corner of Kyle Park looking towards the south west. Waterloo Road is on the right of frame.



Photograph 2: View across the Site from the north east corner looking west, taken from bottom of slope, Waterloo Road right of frame.

2.2 Proposed development

The centre is likely to include community spaces, offices and a leisure centre including a swimming pool. We understand that the swimming pool, including the plant room will extend to an approximate depth of 3 m below the building floor level.

Current ground levels at the Site are approximately 2-2.5 m lower than surrounding land and it is therefore anticipated that the centre will be constructed on top of the current Site ground surface, and therefore require minimal excavation.

Landscaped and car parking areas will likely be built on backfill placed centre footprint to tie in with the final centre floor levels as well as Waterloo and Smarts Roads, and access onto Kyle Park.

The T+T geotechnical site investigation[2] identified that driven steel piles are a preferred foundation option for the centre, to address uncertainty regarding the composition of fill material underlying the Site. Based on the ground conditions encountered (see Section 2.3 below), the piles will be approximately 18 m long.

2.3 Ground conditions

Ground conditions on site are presented in the geotechnical investigation as well as the ground contamination report[3]. A brief summary of the ground conditions beneath the Site is provided in Table 2.2 below.

[2] T+T reference 1003207.v2 – Kyle Park, Geotechnical Assessment Report (November 2018).
[3] T+T reference 1003207.v2 – Kyle Park, Ground Contamination Assessment (November 2018).

Table 2.2: Summary of Ground Conditions

Strata/details	Description
Capping materials	• Grass and thin topsoil layer overlying silt with variable quantities of gravel. Increasing waste (manmade materials) content with depth.
Landfill	• 6.75 to 11 m thick (approximately 28.5 m RL and 24.5 m RL to bottom of material). • Highly variable composition and strength both laterally and vertically. • Silt, sand and gravel matrices and variable composition and type of manmade materials. • Variable organic content, estimated to be locally up to 50% by volume. Organic materials were observed in various states of decomposition. • In-situ testing[4] N counts in these materials ranged from 1 to >50, indicative of low bearing capacity for shallow foundations and potential for large consolidation settlements under development loading. The potential for voids in the waste material cannot be discounted.
Natural strata	• Sands and gravels. • In-situ testing indicates these materials are dense.
Groundwater[5]	• 10 m bgl to 11.9 m bgl (approximately 26 m RL and 24.2 m RL respectively). • Encountered at base of landfill materials and top of the natural strata.

Depths to groundwater are important as they show the available thickness of ground within which landfill gas can generate, accumulate and migrate. Landfill gas is generated in the air space or pore spaces in the subsurface from the breakdown of refuse material. Groundwater provides a natural barrier to deeper gas migration. For the centre, the thickness of landfill material under it ranges from approximately 6.75 m to 11 m and the majority of this material is above the groundwater level. Therefore, it is considered there is the potential for LFG generation.

[4] SPT – standard penetration test N count.

[5] Data collected at same time as LFG monitoring see Section 3.2.

3 Landfill Gas Monitoring

3.1 Published guidance

CIRIA C665[1] provides guidance for LFG monitoring including monitoring well design, the length of monitoring periods and number of monitoring rounds based on the sensitivity of the intended future land use of the land and the LFG generating potential of the waste material.

With respect to the sensitivity of the proposed land use, CIRIA C665 does not specifically assign public facilities a classification. 'Commercial', 'flats' and 'residential' are given as examples of low, medium and high sensitivity developments, respectively. The high sensitivity that might be considered to be appropriate for a public facility is also likely to be moderated by the likely high level of management over building management and design. We therefore consider it appropriate to define the sensitivity of the future centre as 'moderate' for the purposes of assessing the Site according to CIRIA C665.

The Site is located on a landfill that ceased accepting waste in the early 1980s. Accordingly, we consider that the Site is located on an 'older domestic landfill' and the corresponding gas hazard potential of the Site (as defined in Table 4.2, CIRIA C665) is 'moderate'

The following sections describe the rationale and methodology adopted for monitoring well installation and LFG monitoring at the Site.

3.2 Monitoring well installation

For a site with a moderate gas hazard and of moderate end use sensitivity, CIRIA C665 recommends a nominal well spacing of up to 50 m. In April 2019, T+T observed the drilling of four boreholes and installation of monitoring wells in each of the boreholes on the northern, southern, eastern and western edges of the Site, with a spacing of 50-60 m.

Boreholes were drilled by Prodrill using sonic drilling techniques. Each well comprised 50 mm (internal diameter) HDPE pipe with 1 mm slotted sections. The annulus of each well (between the pipe and bore walls) was filled with Walton park gravel to approximately 0.5 m above the screened interval. Bentonite clay was placed above the gravel to within approximately 0.5m of the ground surface. Each well was completed with a push-fit gas tap and lockable well cover, which was cemented in place. The borehole/monitoring well locations are shown in Appendix A.

Table 3.1 below summarises the well construction, groundwater depth monitoring and estimated waste thickness.

Table 3.1: Summary of monitoring well installation details

Monitoring well No.	Groundwater depth (mbgl#)	Well depth	Screen interval#	Waste thickness#
MW201	10.37-11.37	12.0	3-12	2.3-8.9
MW202	10.15-11.13	12.0	3-12	1.5-7.6
MW203	10.08-11.93	12.0	3-12	1.5-10.0
MW204	10.07-11.07	12.0	3-12	1.0-10.4

Notes:

mbgl – metres below ground level.

The location and height (to top of well casing) of each well was undertaken by a CCC appointed contractor.

3.3 LFG Monitoring

According to CIRIA C665 the recommended monitoring frequency for an end use of moderate sensitivity on a site with moderate gas hazard potential is nine monitoring rounds over a duration of six months.

A total of nine rounds of LFG monitoring have been undertaken over a period of eight months (April to November 2019). Monitoring was undertaken during different weather conditions including times when barometric pressure was falling; seven of the events were undertaken when atmospheric pressure was below 1,000 mbar and/or falling.

LFG monitoring was undertaken directly from gas taps fitted to the monitoring wells. The monitoring was conducted using either a GA2000 or GA500 meter. For field quality assurance purposes, prior to monitoring, the meter was bump calibrated for methane, carbon dioxide and oxygen concentrations in air. Monitoring involved taking measurements of LFG concentrations at one-minute intervals until the readings stabilised, with the stable and peak measurements recorded.

3.4 Monitoring Results

The April to November 2019 LFG monitoring data is presented in Appendix B.

Table 3.2 below summarises the peak values of individual gases recorded during the monitoring events for each borehole.

Table 3.2: LFG monitoring results (peak data)

Monitoring well	Methane	Oxygen	Carbon dioxide	Carbon monoxide	Hydrogen sulphide	Volatile organic compounds[6]	Gas flow rate
	(% v/v)			(ppm)			(l/hr)
MW201	7.9	0.9	22.4	1	17	11.5	0.4
MW202	1.9	20.9	21.8	1	14	3.5	0.4
MW203	20.1	0.1	21.3	1	12	6.7	0.2
MW204	25.9	0.4	29.5	11	>1,000	23.5	0.3
Maximum recorded	*25.9*	*20.9*	*29.5*	*11*	*>1,000*	*23.5*	*0.4*

[6] Recorded with photo-ionisation detector (PID), measure/indication of presence of broad array of volatile organic compounds (lamp strength 10.6 eV).

4 Landfill Gas Risk Assessment

The use of gas screening values (GSV) can assist in understanding the risk to buildings from the presence of LFG. The GSV is calculated by multiplying the measured gas flow rate by the concentration of methane and carbon dioxide.

A number of guidance documents utilise GSV to determine the risk from LFG to a development/land use. Generally, the GSV is calculated using the maximum flow rate and concentrations from all monitoring wells which gives a worst-case gas screening value. The GSV can also be calculated for each monitoring well to understand the variability in the level of risk over a site area.

The level of risk based on the GSV is determined based on the ranges outlined in Table 4.1 below (based on CIRIA C665 – table 8.5).

Table 4.1: Level of risk

Characteristic Situation	Risk	Calculated GSV	Additional comments	Typical source of generation
1	Very low risk	<0.07	Typical methane <1% and/or carbon dioxide <5%. Otherwise consider increase to situation 2.	Natural soils with low organic content. Typical made ground.
2	Low risk	<0.7	Borehole airflow rate not to exceed 70 l/h. Otherwise consider increase to situation 3.	Natural soil, high peat/organic content. Typical made ground.
3	Moderate risk	<3.5	-	Old landfill, inert waste, mine working flooded.
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mine working – susceptible flooding, completed landfill.
5	High risk	<70	-	Mine working unflooded inactive with shallow workings near surface.
6	Very high risk	>70	Development not recommended.	Recent landfill site.

The GSV has been calculated for each monitoring period for each borehole and the calculated GSVs and the risk for the site are outlined in Table 4.2 below.

Table 4.2: Gas Screening Values

Monitoring Well	Methane	Carbon dioxide	Risk based on GSV	CH4>1%	C02 >5%	Overall Risk
MW201	0.03	0.09	Low	Yes	Yes	Low
MW202	0.01	0.09	Low	Yes	Yes	Low
MW203	0.04	0.04	Very low	Yes	Yes	Low
MW204	0.08	0.09	Low	Yes	Yes	Low
Max all boreholes	0.10	0.12	Low	Yes	Yes	Low
Average all boreholes and rounds	0.01	0.02	Very low	Yes	Yes	Low

Based on the LFG monitoring completed, according to the methodology set out in CIRIA C665, LFG risk at the Site can be characterised as LOW.

5 Centre LFG Protection Measures

The risk assessment identified an overall low risk for the centre from LFG generated by the landfill materials beneath and adjacent to the Site. Therefore, to protect the users of the centre as well as the building itself (as a CCC asset) LFG management or mitigation measures must be included in the building design to manage the risk.

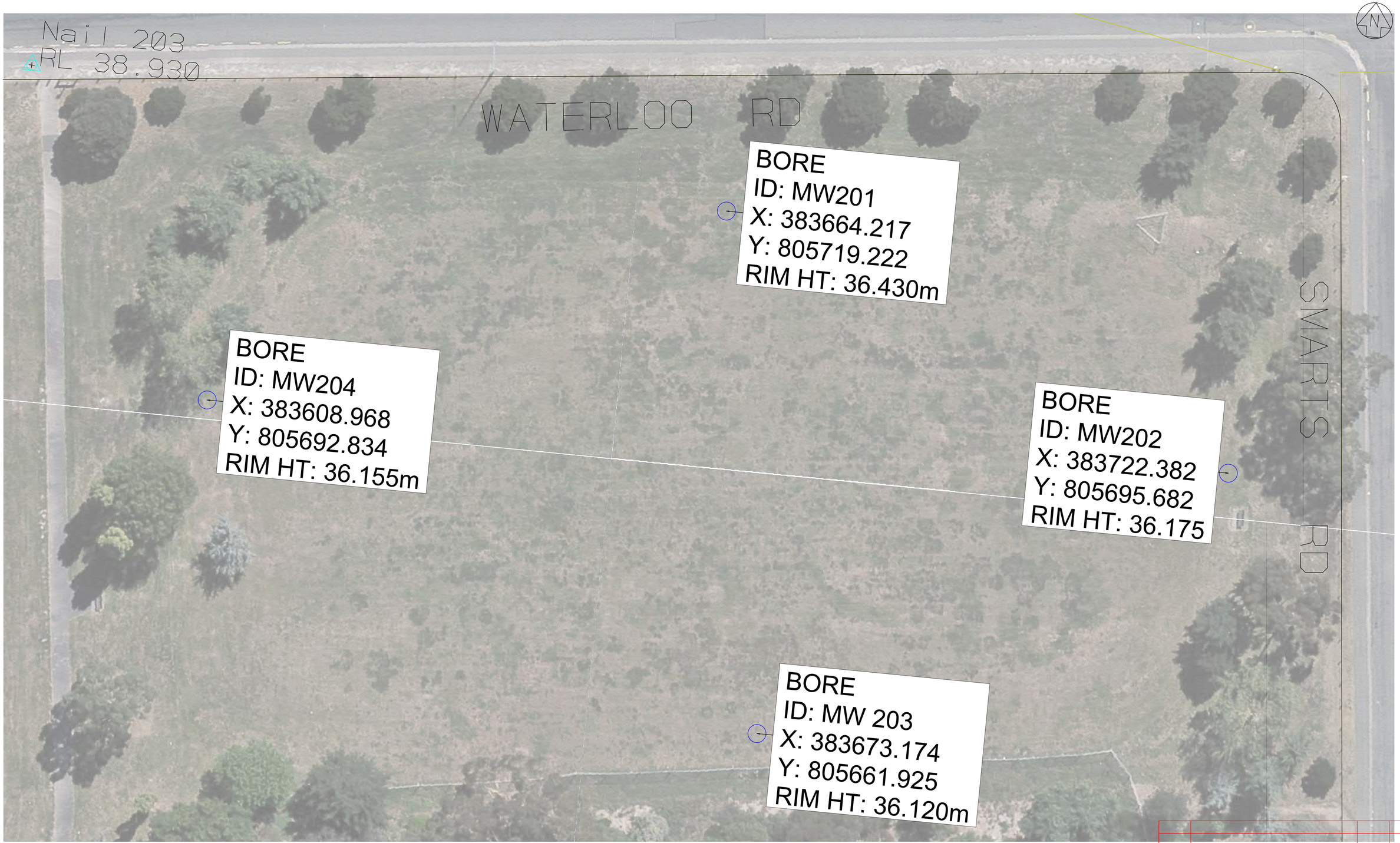
For low risk sites, according to CIRIA C665 typical LFG protection measures include:

- A cast in-situ reinforced concrete floor slab with minimal penetrations, with:
  - All penetrations through floor slab sealed.
  - The use of water bars within construction joints.
  - Penetrations minimised where possible.
- A methane resistant geomembrane.
- A sub floor slab pressure relief venting system. This typically comprises a layer of low fines aggregate with perforated pipework laid within the layer at regular spacings. The venting layer is connected to vertical risers which extend above the centre's rooftop to safely vent the LFG, the addition of cowls at the top of a riser helps to draw air through the venting system.

These are the basic measures for LFG protection measures for the centre based on the monitoring completed to date. Further development of the LFG protection measures will be required during building design.

Appendix A: Figure

- **CCC Bore Location Plan with survey co-ordinates**



GEOSPATIAL REGISTRATION OF AERIAL IMAGERY MAY NOT BE IN TERMS OF LAND XML BOUNDARY DATA
BOUNDARY LOCATIONS SUBJECT TO CADASTRAL SURVEY

12d Working Folder: S:\Project RPS\02301 - Kyle Park\12d\Survey\F11390

ISSUE	AMENDMENT	SIGNED	DATE

Christchurch City Council

TECHNICAL SERVICES & DESIGN

HEIGHT DATUM	CCD Post Jan 2014		NAME	SIGNED	DATE
ORIGIN BM	BM0140 (EHBT)	SURVEYED BY	D Babbage		May 2019
RL	19.342	PROCESSED BY	D Babbage		May 2019
SURVEY LB	GNSS	CHECKED BY			
COORD DATUM	Mt Pleasant 2000	NORTHING		EASTING	
ORIGIN					
SITE TBM					
12D FILE REF	F11390	PRINTED ON	Mon Jul 01 07:38:33 2019		

PROJECT TITLE: Kyle Park

DRAWING TITLE: New Bore Locations

SAP/WBS NUMBER: 721/120/9/9/3/3

FILE NUMBER: RPS2301

ORIGINAL SHEET SIZE: A1

DRAWING NUMBER: RPS2301- 02

SCALES: 1:200

SHEET: 1 OF 1

Appendix B: Landfill Gas Monitoring Results

Proposed Hornby Community Centre - Landfill Gas Monitoring data (April-November 2019)

Well ID	Date	monitoring result % v/v			monitoring result ppm		Relative pressure (mbar)	Barometric pressure (mbar)	Flow rate (l/hr)	PID range (ppm)	Depth to Water (mbgl)	GSV		Char Situation
		Methane (CH_4)	Oxygen (O_2)	Carbon Dioxide (CO_2)	Hydrogen Sulphide (H_2S)	Carbon Monoxide (C0)						CH4	CO2	
MW201	29.04.19	7.9	0.0	22.4	17	not monitored	0.6	994	0.2	0	11.37	0.0158	0.0448	2
	03.05.19	5.3	0.9	20.3	1	0	0.03	1022	0.0-0.1	0.0-0.8	11.34	0.0053	0.0203	2
	06.06.19	6.3	0.0	18.6	17	1	0.0 to -0.03 (fixed at -0.03)	986	0	0-0.2	11.21	0	0	2
	12.07.19	5.7	0.0	17.8	0	1	0.12 to 0.07 (fixed at 0.07)	999	0.1	3.5-5.2	11.23	0.0057	0.0178	2
	23.08.19	7.0	0.0	18.2	0	0	-0.05 to 0.02 (fixed at 0.02)	989	0.2-0.3 (fixed at 0.3)	0.0-1.0 (settled to 0.0-0.1)	10.82	0.021	0.0546	2
	10.10.19	5.4	0.0	18.4	0	0	0	1003	0.4	0.0-0.1 (mostly 0.0)	10.44	0.0216	0.0736	
	22.10.19	1.0	0.0	19.1	0	0	0.12	993	0.2	0.0-0.1	10.37	0.002	0.0382	
	13.11.19	5.4	0.0	19.2	0	1	0.3 to 0.02 (fixed at 0.02)	991	0.2	2.4-11.5 (mostly 8.0-11.5)	10.45	0.0108	0.0384	
	19.11.2019	5.1	0.0	19.3	0	1	0.07 steady	992	0.3	0.2-2.5 (mostly 0.2)	10.47	0.0153	0.0579	
	13.12.2019	3.7	0.0	19.7	0	1	-0.81 to -0.14 (fixed at -0.14)	993	0	9.0-10.0	10.79	0	0	
MW202	29.04.19	1.9	0.3	21.8	14	not monitored		994	0	0	11.13	0	0	2
	03.05.19	0.2	20.9	1.0	0	0	0.14	1022	0.4	0	11.11	0.0008	0.004	1
	06.06.19	1.3	0.0	20.0	2	0	-0.07	986	0.1	0	10.98	0.0013	0.02	2
	12.07.19	1.0	0.1	17.3	9	0	-0.02	997	0.1	0.0-3.5	10.99	0.001	0.0173	1
	23.08.19	1.2	0.1	18.3	0	0	-1.0 to -0.09 (fixed at -0.09)	990	0.2-0.3 (fixed at 0.3)	0.0-0.1	10.59	0.0036	0.0549	2
	10.10.19	1.0	0.2	18.6	0	0	0.1	1003	0.3 (initially 0.2)	0.0-0.1 (mostly 0.0)	10.20	0.002	0.0372	
	22.10.19	1.0	0.0	19.1	0	0	-0.12 to -0.03 (fixed at -0.03)	993	0.1	0.1-1.8 (mostly 0.1-0.6)	10.15	0.001	0.0191	
	13.11.19	0.9	0.2	19.5	0	1	0.52 to 0.09 (fixed at 0.09)	992	0.2	0.0-0.1 (mostly 0.0)	10.23	0.0018	0.039	
	19.11.2019	0.8	1.1	18.2	0	1	-0.19 to -0.09 (fixed at -0.09)	992	0.3-0.2 (fixed at 0.2)	0.2	10.24	0.0016	0.0364	
	13.12.2019	1.1	0.3	20.6	0	1	-0.07 steady	992	0	0.1-1.2	10.56	0	0	

NOTE - all values are peak values

Proposed Hornby Community Centre - Landfill Gas Monitoring data (April-November 2019)

Well ID	Date	monitoring result % v/v			monitoring result ppm		Relative pressure (mbar)	Barometric pressure (mbar)	Flow rate (l/hr)	PID range (ppm)	Depth to Water (mbgl)	GSV		Char Situation
		Methane (CH_4)	Oxygen (O_2)	Carbon Dioxide (CO_2)	Hydrogen Sulphide (H_2S)	Carbon Monoxide (C0)						CH4	CO2	
MW203	29.04.19	17.5	0.0	18.6	12	not monitored		994	0	1.3-1.6	11.14	0	0	2
	03.05.19	13.4	0.1	17.5	0	0	0.10	1022	0	1.7-3.4	11.04	0	0	2
	06.06.19	14.4	0.0	17.3	6	0	0.09 dropping steadily to -0.02 (fixed at -0.02)	986	0	1.3	10.91	0	0	2
	12.07.19	12.7	0.0	18.1	10	1	0.02 to 0.03 (fixed at 0.03)	998	0.1	2.0-2.4	11.93	0.0127	0.0181	2
	23.08.19	15.0	0.0	19.8	5	0	-0.07 to 0.05 (fixed at 0.05)	990	0.2	0.2-6.7 (mostly 3.0-6.0)	10.52	0.03	0.0396	2
	10.10.19	18.6	0.0	21.1	2	0	0.12	1003	0.2	2.6-3.1	10.13	0.0372	0.0422	
	22.10.19	19.5	0.0	21.2	3	0	-0.17 to 0.03 (fixed at 0.0)	993	0.2	2.3-2.8 (steady at 2.7)	10.08	0.039	0.0424	
	13.11.19	20.1	0.0	21.2	1	1	2.4 to 0.02 (fixed at 0.02)	991	0.2	1.4-4.6 (mostly 2.4-3.0)	10.16	0.0402	0.0424	
	19.11.2019	20.0	0.0	21.3	0	0	-0.69 to -0.03 (fixed at -0.03)	993	0.2	2.8-3.3	10.18	0.04	0.0426	
	13.12.2019	16.9	0.0	21.0	0	1	-0.03 to -0.07 (fixed at -0.07)	993	0	0.5-2.8 (mostly 0.8-2.0)	10.49	0	0	
MW204	29.04.19	25.9	0.1	29.5	>1000	11.00	-0.26	991	0	0	11.07	0	0	2
	03.05.19	10.0	0.4	23.8	119	0	-0.20	1022	0.0 to -0.1	0.0-0.1	11.03	0	0	2
	06.06.19	23.0	0.0	29.2	706	1	0.0 to 0.2 (fixed at 0.0)	986	0.0 to 0.1	6.3-11.5 (mostly 6.7, affected by breeze)	10.90	0.023	0.0292	2
	12.07.19	23.6	0.0	29.0	809	1	1.2 to 0.05 (fixed at 0.05)	997	0.1	0.0-5.3	10.92	0.0236	0.029	2
	23.08.19	9.8	0.0	24.0	374	0	-0.14	990	0.2	0.0-0.4 (settled at 0.1)	10.51	0.0196	0.048	2
	10.10.19	16.4	0.0	26.6	429	1	-0.12	1003	0.2	0.6-22.6 (mostly 12-13)	10.12	0.0328	0.0532	
	22.10.19	22.4	0.0	28.6	501	1	-1.65 to -0.05 (fixed at -0.05)	992	0.1	10.3-13.0 (mostly 10.5-11.5)	10.07	0.0224	0.0286	
	13.11.19	22.4	0.0	29	>1000	1	-0.3 to 0.03 (fixed at 0.03)	991	0.3-0.2 (fixed at 0.2)	9.5-23.5 (mostly 12.5-14.0)	10.15	0.0448	0.0578	
	19.11.2019	18.2	0.0	28	472	1	-0.02	993	0.2-0.1 (fixed at 0.1)	0.0-2.9 (mostly 0.0)	10.16	0.0182	0.0278	
	13.12.2019	19.7	0.0	27.7	>1000	1	0.29 to 0.19 (fixed at 0.19)	993	0.0-0.1 (fixed at 0.1)	0.6-11.4 (mostly 7.0-8.0)	10.48	0.0197	0.0277	

NOTE - all values are peak values

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